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# A LOOK AT THE PROTEIN SITUATION FOR LIVESTOCK IN 1952

UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Agricultural Economics

Washington, D. C.
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This report brings to date two processed reports of the Bureau of Agricultural Economics - "The Deficit in Protein for Livestock", issued in April 1946 and "A Look at the Protein Situation for Livestock", issued in March 1950.

# A LOOK AT THE PROTEIN SITUATION FOR LIVESTOCK

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## INTRODUCTION

Much less protein is fed to livestock in this country than is needed for balanced nutrition. More high-protein feeds are fed per animal now than before or during World War II. Not enough protein is produced to satisfy the nutritional needs of each kind of livestock.

The number of livestock has contracted somewhat from the high level of 1950 and 1951. More feed grains are being used up than were raised in 1951. The supply of protein feeds per animal unit is a near record, and is exceeded only by that of 1950. However, with a large feed-grain crop in prospect it is worthwhile to take a look at the protein situation to see where we stand.

## METHOD OF PROCEDURE

If we should use the recommended levels of protein content of the ration as given in feeding standards for each kind of livestock we would be far short of the protein needed. Preparatory to taking this look we computed, for each year since 1937, the percentage of digestible protein needed in all concentrates for all livestock combined and compared this with the protein in the concentrates believed to have been fed (table 1). This calculation shows that in any recent year enough protein for this purpose would have required around 5 million tons of additional soybean meal or its equivalent. This would be about 50 percent more than the total output of oilseed meals in 1951. This estimate may be low. It does not allow for the overfeeding of protein that normally takes place, such as the feeding of more cottonseed meal by some farmers in the South than is necessary from the standpoint of maintaining the protein balance.

Table 1.- Deficit in protein for all livestock, using requirements given in feeding standards as the quantity needed, 1937-51

| Feeding year beginning October 1 | Concentrates fed 1/ | Percentage digestible protein needed in concentrate feeds | Total digestible protein needed | Digestible protein fed | Deficit in digestible protein | Deficit expressed in soybean meal equivalent | Deficit in soybean meal equivalent per animal unit |
|---|---|---|---|---|---|---|---|
| | Million tons | Percent | Million tons | Million tons | Million tons | Million tons | Pounds |
| 1937-41 av. | 102.5 | 11.6 | 11.9 | 10.3 | 1.6 | 4.3 | 63 |
| 1942-46 av. | 130.4 | 11.8 | 15.4 | 13.2 | 2.2 | 5.9 | 72 |
| 1947 | 106.9 | 11.9 | 12.7 | 11.3 | 1.4 | 3.9 | 55 |
| 1948 | 115.5 | 11.9 | 13.8 | 12.1 | 1.7 | 4.6 | 62 |
| 1949 | 123.0 | 12.0 | 14.8 | 12.8 | 2.0 | 5.5 | 70 |
| 1950 | 125.0 | 12.0 | 15.0 | 13.2 | 1.8 | 4.8 | 59 |
| 1951 | 128.1 | 12.0 | 15.4 | 13.5 | 1.9 | 5.0 | 60 |

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1/ All grain (excluding corn in silage) and byproduct feeds, including seeds and skimmilk fed.

The method of computing the "percentage of digestible protein needed" shown in column 2 of table 1 is given in more detail in the report, "The Deficit in Protein for Livestock." The recommendations are summarized briefly in the following paragraph. 1/

The percentage of crude protein in the concentrate ration recommended by dairy husbandmen for dairy cows was varied by regions depending largely on the kind of hay available in the region, length of pasture season, etc. It averaged about 16 percent for the country as a whole. 2/ The recommended level was 15 percent for laying flocks, 18 percent for growing chickens, 20 percent for broilers, and 19 percent for turkeys. This averaged about 16.4 percent for all poultry. A level of 14 and 15 percent was recommended for hogs, the lower figure being used for most of the Middle West where pasture is generally available. The protein requirements for dairy heifers, beef cattle, and sheep, were computed on the basis of Morrison's recommendations in Feeds and Feeding. 3/ For all livestock combined the crude protein required comes to about 15.0 pounds (12.0 pounds digestible protein) per 100 pounds of grain and other concentrates fed. This figure has gradually increased as the number of horses and mules has decreased. Horses and mules require less protein in relation to grain fed than do other kinds of livestock.

## IMPORTANCE OF PROTEIN

Protein is an important constituent of all livestock products. It makes up the following percentages of the dry matter of leading animal products: 36 percent of a Good-grade beef carcass, 27 percent of a Medium-grade hog carcass, 60 percent of a chicken, 49 percent of an egg, and 27 percent of milk. On a comparable basis, dry beans contain about 24 percent protein and wheat flour about 13 or 14 percent. Foods of animal origin are high in protein compared with foods of plant origin. Enormous quantities of protein of both animal and plant origins are eaten by livestock to supply the protein in the meat, eggs, and milk used for food in this country. Young growing animals are fed proportionately larger quantities of protein than mature animals, poultry or those being fattened.

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1/ Detailed recommendations will be found in "Recommended Nutrient Allowances for Poultry Swine and Other Kinds of Livestock," by the National Research Council.

2/ In a report of the Bureau of Dairy Industry, New Ideas on Protein in Dairy Cow Rations (BDI-Inf. 116, March 1951), recent experimental work indicated that less protein is required for dairy cows than was formerly recommendeds. It appears safe to recommend rations containing 3 to 4 percent less protein with grain mixtures than was previously recommended for average farm cows. This means for example, that a ration containing 15-percent protein can be used instead of one containing 18 percent. Such a change would result in a reduction of 17 percent in the calculated protein requirements.

3/ Morrison, F. B. Feeds and Feeding. A Handbook for the Student and Stockman, Ed. 21, 1207 pp. Ithaca, New York, 1949.

When a ration is fed that contains much less protein than is needed, its efficiency is lowered. In other words, it takes more pounds of grain to make the same gain in weight if too little protein is fed. In the case of mature animals, the protein requirements for repair of and addition to body tissues are small. If only this quantity were fed it would be too small from the standpoint of digestibility of the ration. In order to do their work most effectively, the bacteria in the digestive tract seem to require a certain balance between protein and the easily digested carbohydrates such as grain.

Corn is the principal feed for hogs. It contains protein but not enough, nor the right kind, for a balanced ration. When pigs weighing 69 pounds were fed only on corn they gained only 72 pounds in 4 months and used 642 pounds of corn to make 100 pounds of gain. 4/ Other pigs that were fed corn and tankage made twice as much gain in the same time and used only 387 pounds of corn and 42 pounds of tankage per 100 pounds of gain. This is an extreme example, as probably a relatively small percentage of farmers today feed only corn. But, if this experiment had started with weanling pigs the results would have been even more striking, for the requirements are much heavier in the early stages of growth than later on.

In regard to feeding protein to beef cattle, Morrison makes this statement (Feeds and Feeding 21st Ed. p. 779), "It is believed, however, that if the protein supply is reduced much (below standard) the gains are apt to be lessened, and more feed required per 100 pounds gain. Also there will be a tendency for the cattle to sell at a lower price because of less satisfactory finish." With regard to a protein-poor ration for fattening cattle, he states, "When care is taken to feed no more protein supplement than is actually needed to balance the ration each 100 pounds of such a supplement as linseed meal, soybean oil meal or cottonseed meal will be equal in value to 250 to 300 pounds of grain or grain equivalent."

The economic importance of sufficient protein then is that it reduces the quantity of grain and other feeds required to make the meat, eggs, and milk, that farmers produce. To figure out how much it would mean to a farmer to feed a ration containing 15-percent protein to his hogs, chickens, or cows, (instead of 12 percent) is a job in itself, and not to be undertaken here. The kinds of hay, pasture, and grain that are available must be taken into account. The prices of feeds and of the products must also be considered. If the additional protein needed to balance the ration costs so much that the combination of the feed saved and the additional product produced would not pay for it, then it would not be profitable for the farmer to increase the protein content of the ration. Under conditions of favorable prices, such as have prevailed in recent years, there is no doubt but that much more high-protein feed would have been fed at prevailing prices if it had been available. Although it might not be economical to feed all of our livestock as much protein as is called for by feeding standards, there is no doubt that it would pay to feed the herds and flocks on commercial farms a better - balanced ration than they now receive.

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4/ Morrison, Feeds and Feeding, p. 480. See also Ohio State Agricultural College Extension Service Bul. 203, tables 40 to 50.

## SOURCES AND SUPPLY

Protein for livestock feed comes from several sources. About 23 percent of the total protein consumed by livestock comes from grains fed, 13 percent from the commercial high-protein byproduct feeds, 5 percent from other byproduct feeds, 25 percent from hay, silage, and stover, and 34 percent from pastures. These figures are only approximate as the quantity that comes from pasture and hay cannot be estimated closely. Pasture is the most important single source of protein. Young grass has as much protein on a dry-matter basis as some mill feeds and other concentrates, but the protein content of grasses usually decreases as the season advances, and in a few weeks the grasses may contain only half as much protein as in the early weeks.

Hay is a valuable source of protein, but the protein content of different kinds of hay varies widely. Alfalfa hay contains about 10 percent of digestible protein, mixed clover and timothy about 5 percent and many of the wild hays less than 3 percent. It is estimated by the writer that the average of all hay is about 7.2 percent. The average protein content of hay is somewhat larger than before World War II, because of an increase in production of alfalfa. The protein content of hay is affected to some extent by the stage at which the hay is cut, by the method of curing, the degree of fertilization of the soil, and the application of nitrogenous fertilizers. The present interest by farmers in improved haymaking practices may result in some increase in protein for hay-consuming livestock.

About 20 to 25 percent of the total quantity of protein fed comes from corn, oats, and other grains. Corn alone accounts for more than half of the protein in grains. An influential development has been the large increase in production of hybrid corn, which has only 6.5 percent digestible protein compared with 7 percent in open-pollinated varieties.5/ This means that it takes more than a million more tons of oil meal to off-set the lower protein content of hybrid corn, compared with the use of open-pollinated varieties before the war for a crop of the same size. This is about one-eighth of the oil meal produced annually in the last year or two.

Oil meals and other commercial high-protein feeds account for about 9 percent of the total protein supply and about one fifth of the quantity in all concentrate feeds. High-protein feeds are of great importance, however, as they are used by feed manufacturers and farmers to mix with grains, mill feeds, etc., to raise the average protein content of the ration. The oil meals comprise about three-fourths of the tonnage of commercial high-protein feeds, and soybean cake and meal have accounted for most of the 125 percent increase in oil meals in the last two years as compared with prewar (table 2).

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5/ Morrison, F. B., Feeds and Feeding, table 1.

Table 2.- High-Protein Feeds: Estimates use for feed, year beginning October, average 1937-41, annual 1946-51 1/

| Item | Average 1937-41 | 1946 | 1947 | 1948 | 1949 | 1950 2/ | 1951 3/ |
|---|---|---|---|---|---|---|---|
| | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons |
| PROTEIN FEEDS | | | | | | | |
| Oilseed cake and meal | | | | | | | |
| Soybean cake and meal | 1,258 | 3,745 | 3,383 | 4,158 | 4,517 | 5,709 | 5,550 |
| Cottonseed cake and meal | 1,958 | 1,434 | 1,953 | 2,271 | 2,382 | 1,849 | 2,600 |
| Linseed cake and meal | 481 | 370 | 606 | 620 | 670 | 732 | 575 |
| Peanut cake and meal | 74 | 98 | 122 | 96 | 93 | 130 | 100 |
| Copra cake and meal | 134 | 190 | 177 | 160 | 199 | 221 | 175 |
| Total | 3,905 | 5,837 | 6,241 | 7,305 | 7,861 | 8,641 | 9,000 |
| Animal proteins | | | | | | | |
| Tankage and meat scraps | 728 | 740 | 823 | 854 | 842 | 882 | 900 |
| Fish meal | 235 | 191 | 213 | 230 | 264 | 276 | 300 |
| Commercial dried milk products | 142 | 115 | 90 | 95 | 100 | 85 | 80 |
| Noncommercial milk products | 1,829 | 1,300 | 1,260 | 1,280 | 1,300 | 1,250 | 1,225 |
| Total | 2,934 | 2,346 | 2,386 | 2,459 | 2,506 | 2,493 | 2,505 |
| Grain protein feeds | | | | | | | |
| Gluten feed and meal | 690 | 1,040 | 799 | 848 | 926 | 966 | 900 |
| Brewers' dried grains | 119 | 229 | 228 | 233 | 233 | 241 | 240 |
| Distillers' dried grains | 203 | 410 | 353 | 334 | 352 | 642 | 450 |
| Total | 1,012 | 1,679 | 1,380 | 1,415 | 1,511 | 1,849 | 1,590 |
| Total commercial high-protein feeds | 6,022 | 8,562 | 8,747 | 9,899 | 10,578 | 11,733 | 11,870 |

[1] Production plus imports; excluding exports, utilization for food, and other non-feed uses. Adjusted for changes in stocks for the following feeds for which stock data have been compiled: Cottonseed cake and meal and brewers' and distillers' dried grains, 1937-51, peanut cake and meal, 1938-51, alfalfa meal, 1944-51, soybean, linseed, and copra cakes and meals, February 1949 to date.

[2] Preliminary.

[3] Preliminary estimates based on indications in May.

Gluten feed and meal, brewers' dried grains, and distillers' dried grains, account for 13 percent of the total commercial high-protein feeds used in recent years. Each has increased as compared with prewar, and as a group are more than 50 percent larger in tonnage. The commercial animal-protein feeds, as a group, comprise only about 11 percent of the tonnage of commercial high-protein feeds and have increased about 15 percent in tonnage, compared with prewar. Commercial dried-milk products are lower than prewar, whereas tankage, meat scrap, and fish meal are 20 to 30 percent larger. The dry equivalent of skimmilk fed as a liquid is nearly as large as that of all other animal-protein feeds combined, but is about one-third less than prewar, largely because a higher percentage of all milk is consumed as whole milk now than before the war.

The supply of high-protein feeds for the current feeding year (1951-52) is not only high in tonnage compared with past years (table 2) but is high in comparison with the livestock to be fed (table 3). There are 157 pounds of high-protein feeds per animal unit of all livestock except horses and mules. This is less than in 1950-51 but higher than in all other years. The supply of oil meals per animal unit is 108 pounds, a new high. The supply of animal proteins per animal unit does not differ much from the supply in the last several years and is below prewar. Production of tankage and meat scrap varies with the number of livestock slaughtered. The supply of high-protein feeds in 1951-52 is also high relative to the total concentrates to be fed, amounting to 10.5 percent of the total, a new high. Thus, from a historical standpoint the quantity of high-protein feeds is relatively abundant.

Supply per animal unit does not tell the whole story, however, as livestock production per animal is considerably above the prewar average. Milk per cow, eggs per hen, and the average weight of hogs, for several years have been higher than before. This means more proteins and other feeds fed per animal because of greater production per animal.

The average price of oil meals in 1951 was 102 percent of the 1947-49 average, while prices of feed grain were 98 percent of their 5-year average and prices of livestock were 115 percent of their average (table 4). Prices of oilseed meals were thus relatively lower than livestock prices but were above feed-grain prices. They were 10 to 15 percent higher in price in 1951 than in 1949 and 1950. The average price of oil meals in 1951 was not especially high in relation to livestock prices or grain prices. Despite the increase of one-third in the production of high-protein feeds since 1946, the price of oilseed meals in 1951 was a little higher relative to feed grains than in 1946, indicating an increase in demand.

The price of animal-protein feeds in 1951 averaged 98 percent of the 1947-49 average and about the same as in 1950 but below 1949. Prices of animal proteins in 1951 were lower relative to oilmeals than in the previous two years.

Table 3.- Consumption of high-protein feeds in relation to livestock and feed concentrates fed 1937-1951

| Feeding season beginning October 1 | Protein feeds | | | | | Animal units of grain-consuming livestock | | Consumption of protein feeds | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Animal protein | | Total | | | Per animal unit | | | | Deficit in soybean meal equivalent per animal unit |
| | Oilseed meal (1) | Grain protein feeds (2) | Excluding skimmilk fed as a liquid (3) | Including skimmilk fed as a liquid (4) | including skimmilk fed as a liquid (5) | Total except horses & mules (6) | Poultry and hogs (7) | Col. 1 divided by Col. 6 | Col. 3 divided by Col. 7 | Col. 4 divided by Col. 7 | Col. 5 divided by Col. 6 | |
| | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | Million units | Million units | Pounds | Pounds | Pounds | Pounds | Pounds |
| 1937-41 average | 3,906 | 1,012 | 1,102 | 2,931 | 7,849 | 136.1 | 92.7 | 57.4 | 23.8 | 63.2 | 115.3 | 63 |
| 1942 | 6,088 | 1,513 | 1,174 | 2,884 | 10,485 | 176.7 | 127.8 | 68.9 | 18.4 | 45.1 | 118.7 | 68 |
| 1943 | 6,255 | 1,517 | 1,271 | 2,816 | 10,588 | 177.9 | 127.8 | 70.3 | 19.9 | 44.1 | 119.0 | 67 |
| 1944 | 6,206 | 1,715 | 1,106 | 2,571 | 10,492 | 158.8 | 108.8 | 78.2 | 20.3 | 47.3 | 132.1 | 69 |
| 1945 | 5,803 | 1,341 | 1,039 | 2,399 | 9,543 | 154.0 | 106.4 | 75.4 | 19.5 | 45.1 | 123.9 | 81 |
| 1946 | 5,837 | 1,679 | 1,046 | 2,346 | 9,862 | 147.7 | 100.7 | 79.0 | 20.8 | 46.6 | 133.5 | 75 |
| 1947 | 6,241 | 1,380 | 1,126 | 2,386 | 10,007 | 142.3 | 98.3 | 87.7 | 22.9 | 48.5 | 140.6 | 55 |
| 1948 | 7,305 | 1,415 | 1,179 | 2,459 | 11,179 | 149.3 | 104.7 | 97.9 | 22.5 | 46.9 | 149.8 | 62 |
| 1949 | 7,861 | 1,511 | 1,206 | 2,506 | 11,878 | 156.2 | 111.4 | 100.7 | 21.7 | 45.0 | 152.1 | 70 |
| 1950 | 8,641 | 1,849 | 1,243 | 2,493 | 12,983 | 163.1 | 117.5 | 106.0 | 21.2 | 42.4 | 159.2 | 59 |
| 1951 | 9,000 | 1,590 | 1,280 | 2,505 | 13,095 | 166.7 | 119.4 | 108.0 | 21.4 | 42.0 | 157.1 | 60 |

USDA - BAE August 1952.

Table 4.- Index numbers of prices of feeds and livestock, 1937-41 average and 1945 to 1951
(1947-49 = 100)

| Year | Feed grains | Oilseed meals | Soybean meal | Animal-protein feeds | Livestock and livestock products |
|---|---|---|---|---|---|
| 1937-41 average | 38 | 41 | 38 | 41 | 40 |
| 1945 | 70 | 67 | 63 | 62 | 72 |
| 1946 | 88 | 89 | 86 | 76 | 83 |
| 1947 | 114 | 104 | 102 | 96 | 99 |
| 1948 | 113 | 105 | 106 | 94 | 108 |
| 1949 | 73 | 90 | 92 | 110 | 94 |
| 1950 | 82 | 93 | 91 | 97 | 96 |
| 1951 | 98 | 102 | 98 | 98 | 115 |

## USE OF HIGH-PROTEIN FEEDS IN COMMERCIAL MIXED FEED

A significant change in the situation, compared with prewar, is the great increase in the use of commercial mixed feeds, especially poultry feeds. The Bureau of the Census reported that 22 million tons of poultry and livestock feeds were manufactured in 1947. In 1939 only 13 million tons of prepared feeds were reported. The feed-mixing industry had about twice as many establishments and more than 2 1/2 times as many production workers in 1947 as in 1939. The 22 million tons manufactured in 1947 accounted for nearly one-fifth of the total concentrates fed to all livestock in this country. The 11.7 million tons of poultry feeds manufactured in 1947 were more than 40 percent of all feed fed to poultry. Probably more than 30 million tons of commercial mixed feed was used in 1951.

The 1947 Census shows the materials that go into mixed feed. From this it was estimated by the writer that nearly all of the fish meal and scrap and dried milk and more than 90 percent of the tankage and meat scrap produced goes into mixed feed. The percentages for other kinds of feed were: gluten feed and meal and brewers' and distillers' grains, 80 to 85 percent; soybean meal 70 to 75 percent; linseed meal 40 to 50 percent; cottonseed meal 15 to 20 percent. Fifty-five percent of all oil meal probably has gone into mixed feed and 65 percent of all high-protein concentrates. It was estimated that 40 to 45 percent of all the high-protein feeds used in the mixed-feed industry, in 1947, went into poultry feeds and 35 to 40 percent into dairy feeds. As the mixed-feed industry uses a large part of the output of high-protein feeds, it is easy to understand why, during periods of general shortages, farmers have found it difficult at times to obtain high-protein meals and other primary ingredients.

## What Can Be Done About The Protein Shortage

Dairy cattle and poultry come nearest to obtaining the protein needed for balanced nutrition. The lack of protein balance is probably greatest with respect to hogs. In any case, a large increase in the output of high-protein concentrates would be necessary to balance all livestock rations. Information at hand does not indicate that we are likely to attain this output in the foreseeable future. A principal reason is that most of the high-protein concentrates are secondary products or byproducts from other production processes. They are not produced primarily for protein feeds. Hence changes in the demand for high-protein feeds have relatively little influence on the production of such feeds. The future supply of high-protein concentrates will depend largely on the demand for the primary products of the industries that involve cotton, fats and oils, meat packing, fish canning, manufacture of corn products, and brewing and distilling.

The outlook for soybeans is relatively more favorable than that for most of the other oilseeds. A bushel of soybeans makes about 9 pounds of oil and 48 pounds of meal. The 1937-41 average value of 9 pounds of oil at 6.4 cents a pound and 48 pounds of meal at $30.74 a ton meant a wholesale value of $1.31 for the products from a bushel of beans. The average farm price of beans was 96 cents a bushel or about three-fourths as much as the wholesale value of the product. With oil at, say, 10 cents a pound, and meal at $70 a ton, the total value product from a bushel of beans would be $2.58. Seventy-five percent of this is $1.94, or the price that might be paid for a bushel of soybeans under these assumptions. Under such conditions soybean meal would be the main product and oil the byproduct. The price of oil in the first half of 1952 was about 10 cents a pound while soybean meal has been from $85 to $95 a ton or more. The price of soybeans per bushel during most of the years when they have been increasing in importance has been about 1.6 times the price of corn per bushel. If the price of corn is supported at around $1.60 a bushel a comparable price for soybeans would be 1.6 x 1.60 or $2.56.

An outstanding development in livestock feeding in the last 20 years has been the expansion in consumption of oil meals per animal unit with little change in the price of such feeds relative to feed prices in general. The consumption of oilseed meals per animal unit from 1949-1951, was more than 80 percent above the 1937-41 average, at prices relatively greater than prices of feed grains. This seems to represent a real increase in demand; apparently the wartime increase in demand carried over into peacetime. Probably high prices for livestock and the growth in the mixed-feed industry were the most important influences in this respect. This increase in demand may not continue at as fast a rate, especially if livestock prices decline and some of the newer ideas on animal nutrition take hold.

## NEW DEVELOPMENTS IN PROTEIN REQUIREMENTS

Recently, the Bureau of Dairy Industry conducted an experiment in which grain mixtures with three levels of protein were fed to milk cows, 10 to 11 percent, 14.5 to 15.5 percent and 18.5 to 19.5 percent. Timothy, silage, and a little alfalfa made up the roughage. No pasture was used and most of the cows were on the ration for three consecutive lactations.

There was no marked difference in milk production between the three groups of cows. The conclusion reached was that the protein content of the grain mixture could be 3 or 4 percentage points lower than is now generally recommended. On the basis of this recommendation, dairy cows in this country in the aggregate now are fed more protein than they require from a nutrition standpoint. However, herds in some parts of the country are underfed and in other parts they are fed a good deal more protein than necessary. Where protein feeds are about as cheap as carbohydrate feeds there is no reason for the farmer to restrict the feeding of high-protein feeds compared with feed grains. This is true much of the time in the South and occasionally in other parts of the country.

Another new development is a dry-lot hog feeding experiment conducted by Iowa State College. 6/ The gist of the experiment is that if the hog ration is balanced with respect to Vitamin $B_{12}$, other B vitamins, and trace minerals, and an antibiotic is added, the higher protein levels recommended in the past are not needed. The experiment showed that when an antibiotic was fed the 14 - 11 - 8 percent levels of protein for successive stages of growth produced gains equal to higher levels of protein. The pigs receiving the antibiotic grew faster and with less feed per 100 pounds of gain. Probably when due weight is given to feed economy a less extreme reduction in protein would be indicated.

If it were assumed that a 20-percent reduction were made in the protein required for all hogs, a similar reduction in the requirements for dairy cattle, and no change in the requirements for poultry 7/ or other livestock, the deficit for all livestock shown in table 1 for 1951 would be largely wiped out. It appears that with the new knowledge concerning antibiotics, vitamins, and minerals, the disparity between the protein supply and nutritive requirements may be much less than was formerly thought. However much more experimental feeding will probably be necessary before general acceptance of such a large reduction in protein requirements for hogs and dairy cows.

## Improvement in Hay and Pasture

An additional opportunity to correct the protein deficiency lies in improvement of hay and pasture. The average protein content of hay is probably increasing slowly because of the increased proportions of alfalfa. However, much hay of low quality still is produced. The closer to maturity hay is permitted to stand before it is cut the greater the reduction in protein content. Modern hay-making methods probably have reduced considerably the losses in feed nutrients in hay making. Hay and grass silages are increasing in importance and they contribute to the conservation of forage crops.

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6/ See article in March 1952 Iowa Farm Science, "Hogs Need Less Protein" Damon Catron et.al., Department of Animal Husbandry, Iowa State College.

7/ There are some indications that there may be a small reduction in poultry.

Pasture contributes about one-third of all feed nutrients, including protein, for all livestock. Pasture improvement through such practices as fertilization, reseeding, and renovation increases the total quantity of feed nutrients, including protein. The proportion of protein in pastures is increased, principally through more legumes among the pasture plants. Pasture plants contain more protein while they are young than when near maturity. Most young forage from fertile pastures contains enough protein for cattle and sheep. Pasture reduces the protein needed for hogs fed in the dry lot by nearly half and saves some corn as well. Good pasture will save 5 to 10 percent of the grain and even more of the protein for raising pullets and for laying flocks. The increased activity in pasture building and improvement now going on will enable more cattle to be carried and will contribute to the total feed and protein supply of the country. This is especially true in the South where cattle may be run on pasture of one kind or another the year around.

## Use of Urea 8/ 9/

A relatively recent development on a commercial scale which, from a nutritional standpoint, offers an opportunity to save high-protein concentrates in cattle and sheep rations is the production of urea. Urea is a synthetic chemical product that does not contain any feed energy. It can be utilized only by cattle and other ruminants. If added to a ration that is low in protein but has sufficient starch, the urea is converted into protein by bacteria in the digestive tract of ruminants. The conversion into protein is satisfactory when the urea is fed along with cereal grains but the conversion is poor when it is fed with hay alone. One pound of urea plus 7 pounds of grain will replace about 7 pounds of soybean meal. Therefore it would not pay to feed it if the price of oil meal is only a little above that of grain. It does not pay to use it when a ration containing sufficient protein is already being fed. In experiments, it has generally been found to be more satisfactory for cattle than for sheep. The results with dairy and beef cattle vary somewhat but, in general, it has been satisfactory when fed in combination with liberal quantities of grain. Apparently a considerable supply of easily digestible carbohydrates such as grain and molasses, is necessary to enable the bacteria to work. The more fibrous and less digestible carbohydrates, (as straw, hay, corn stover, and corn cobs) cannot be satisfactorily used with urea unless they are fed along with sufficient, easily digested carbohydrates such as grain or molasses

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8/ A bibliography on the utilization of urea, processed report B.A.I. USDA AHD No. 143.

9/ Processed report, "The Use of Urea as aFeedstuff", N. R. Ellis, B.A.I., L. A. Moore B.D.I. USDA (AHD No. 142).

Urea apparently has possibilities in replacing protein feeds on dairy farms and in cattle feeding. It must be very thoroughly mixed with the grain. The exact conditions under which individual farmers could use urea do not seem to have been determined, as there have been varying results as to palatability, for instance. More than 2 3/4 million tons of high-protein concentrates are used by dairy cows in this country. Probably 70 percent of this is supplied in commercial mixed feeds. Thus it would seem that if a considerable use of urea is to be brought about it must come through mixed feeds. Cattle feeders probably use less than one-half million tons of oil meals. Most of the grain fed to cattle in the feedlot is fed as ear or shelled corn. To use urea it would be necessary to grind the corn and mix in the urea, as it cannot be fed by itself. The other alternative is the purchase of special mixed concentrates which include urea.

Limitations to the use of urea are principally economic. As 6 pounds of grain (or the equivalent) must be fed with each pound of urea to replace 7 pounds of soybean meal, it follows that unless the price of high-protein feeds is considerably higher than the price of grain no economic advantage results in substituting urea for the high-protein feeds. In a typical dairy ration, even when the price of oil meal is 1.6 times the price of corn per pound, the saving in the cost of the concentrate ration by using urea is only 5 percent. In New York State the ratio between the price of oil meal and grain has averaged 1.6 or more in only 4 of 15 years. In Illinois this ratio has averaged 1.6 or more in 9 of 15 years, in California 8 of 15, and in Alabama only 1 of 15. On the other hand, in Colorado in only 2 years was the ratio below 1.6. The greatest price ratio advantage for urea seems to be in the western Corn Belt and the northern Great Plains, where beef cattle are important.

## Vitamin $B_{12}$ and Antibiotic Supplements [10]

In addition to the protein itself, animal protein feeds contain a number of elements, such as vitamins and minerals that are necessary for the growth and reproduction of animals. Before 1948 this unknown complex was called the "Animal Protein Factor". After one of its constituents, $B_{12}$, was identified in 1948, the term "$B_{12}$" was generally used in place of "Animal Protein Factor". Animal feeds that contain $B_{12}$ are meat scraps, tankage, fish meal, and similar products. $B_{12}$ is also obtained as a byproduct from various industrial fermentation processes including the manufacture of antibiotics. Its importance from whatever source derived is to supplement an all-vegetable diet or diets low in animal protein. The addition of $B_{12}$ to a corn-soybean meal ration has brought the growth response of both pigs and chickens in line with those obtained when animal proteins are included in the diet.

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[10] Processed report BAI, USDA "The Use of Vitamin $B_{12}$ and Antibiotic Supplements in Livestock Feeding"(AHD No. 145.)

Production of commercial animal proteins is not much larger than before the war. The price of these feeds in 1951 was about 2 1/2 times the 1937-41 price. The price of oilseed meals increased about the same percentage even though production was more than twice the prewar level. More than 4 times as much soybean meal was produced in 1951 as compared with prewar, but the price maintained its relative position with other feeds. Much of this increase in demand for soybean meal had occurred before the discovery that Vitamin $B_{12}$ added to soybean meal could replace animal proteins for hogs and poultry. Its place as a feed would seem to be strengthened.

Antibiotics are organic compounds with germ-killing properties which are used by the medical world for combating disease. Streptomycin, aureomycin, bacitracin, terramycin, and penicillin are familiar names. It has been found that they stimulate growth in poultry and hogs. There are a number of theories as to how they function, some of which suggest they affect the bacterial content of the intestinal tract in some unknown way. The growth response to antibiotics has been large in the case of runts and unthrifty pigs but has sometimes been important also in the case of healthy pigs. The saving in feed per 100 pounds gain has not been completely evaluated. The shortening of the growth period in itself however has an economic advantage. Antibiotics appear to have acquired an important place in the nutrition and feeding of farm animals but a number of questions concerning their use are still to be answered.

## Production of Amino Acids

A number of different amino acids make up "protein". Some of these are being manufactured synthetically by the chemical industry to be used to step up the content of desirable amino acids in feeds. Just how far this development will go it is hard to say. If it is profitable it could become a real factor in the protein situation.

## IN BRIEF

In brief, four measures are available for increasing the protein content of our feed supply.

(1) Increasing the acreage and yield of good hay and pasture. Yields are improved through the use of improved practices in growing, harvesting, and storage, of hay and grasses, the increased use of fertilizer, and the timely cutting of hay.

(2) Planting larger acreages of soybeans and other oilseeds. But this involves consideration of oil supplies as well as the need for reducing the acreage of intertilled crops in the interest of soil maintenance. Over a period of years soybean meal probably will continue to increase in use, relative to other protein feeds, because the production of other oilseeds is more dependent on the demand for other products than on the demand for meal.

(3) Expansion of the use of urea. From an economic standpoint its greatest advantage is in the western Corn Belt and the Great Plains.

(4) Greater use of Vitamin $B_{12}$ and antibiotics in hog rations. Vitamin $B_{12}$ has an indirect effect in expanding the use of high-protein feeds in that it will allow plant protein to be substituted for animal proteins of higher price.

(5) Production of one or more amino acids by chemical means.